**Results:** US showed a definite gestational sac in four of the 12 patients (33%); the rest had a heterogeneous mass in the cornual region. Thinning of the myometrial mantle was seen in these four patients. The gestational sac appeared eccentric in three of these but in only three of 12 (25%) overall. The endometrial canal or interstitial portion of the tube was identified in 11 of 12 patients (92%). The interstitial line had better sensitivity (80%) and specificity (98%) than eccentric gestational sac location (sensitivity, 40%; specificity, 88%) and myometrial thinning (sensitivity, 40%; specificity, 93%) for the diagnosis of interstitial ectopic pregnancy.

**Conclusion:** The interstitial line sign is a useful diagnostic sign of interstitial ectopic pregnancy.

Index terms: Pregnancy, ectopic, 856.8233 • Pregnancy, ultrasound (US), 856.12981, 856.12983, 856.12984

Radiology 1993; 189:83–87

---

**Materials and Methods**

**Part 1**

We reviewed all interstitial ectopic pregnancies in patients seen at the Health Sciences Centre between January 1986 and February 1993. Patients who did not undergo ultrasound (US) examinations prior to surgery were excluded from the study. The US examinations were performed with various scanners: ESI 1000 and ESI 3000 (Elscint, Haifa, Israel); Ultramark 9 (Advanced Technology Laboratories, Bothell, Wash); Acuson 128 (Acuson, Mountain View, Calif); and Sonoline 2 (Siemens Ultrasound, San Ramon, Calif). Chart reviews of all patients were performed. The available US images were reviewed to assess the relationship of the gestational canal and decidua to the gestational sac or mass associated with the interstitial pregnancy and to evaluate the presence of myometrial thinning and eccentric location of the gestational sac.

In a separate study, we reviewed all ectopic pregnancies at the Health Sciences Centre for the period from January 1989 through July 1992. These data were used to determine the proportion of all ectopic pregnancies that were interstitial.

**Part 2**

To assess the accuracy of the interstitial line in diagnosis of interstitial pregnancy, three radiologists were given the US images obtained in 40 patients chosen by two of the authors (T.E.A., C.S.L.). Ten patients had interstitial ectopic pregnancy (randomly selected from part 1), 10 had other types of ectopic pregnancy, 10 had normal intrauterine pregnancies, and 10 had normal pregnancies with either apparent myometrial thinning or eccentric location of the gestational sac (pseudointerstitial pregnancies). The radiologists were familiar with the concept of the interstitial line but had not previously seen the selected cases and were unaware of the final diagnosis. The radiologists were instructed to indicate sonographic findings, state a diagnosis, and provide treatment recommendations.

**Results**

There were 19 patients with interstitial ectopic pregnancies treated at the Health Sciences Centre from January 1986 to February 1993. Of that group, there was complete information (surgical, pathologic, US) in 12 patients. The remaining seven patients were excluded from the study because US data were unavailable for review.

Nine patients underwent both transvesical and endovaginal sonog-
raphy, two patients underwent only transvesical sonography, and one patient underwent only endovaginal sonography. Five patients underwent Doppler interrogation as part of their examinations.

A gestational sac was identified in four of 12 patients (Table 1). There was thinning of the myometrial mantle to less than 5 mm around the gestational sac in all four patients with a demonstrable gestational sac (Fig 1). An eccentric location of the gestational sac was demonstrated in three of four patients (Fig 1). In one patient, the sac did not appear to be eccentric. This patient had a live interstitial ectopic pregnancy of 12 weeks menstrual age that resulted in rotation of the uterus (Fig 2). This phenomenon has previously been described as the Ruge-Simon syndrome (5).

In the eight patients in whom a gestational sac was not identified, an eccentric heterogeneous mass was demonstrated in the cornual region (Fig 3).

A well-defined double decidual sign was not identified in any of the patients with an interstitial ectopic pregnancy. A thin echogenic line was seen to extend directly up to the center of the interstitial gestational sac (Figs 1, 4) in all four patients with a sonographically demonstrable gestational sac. This finding was also present in seven of the eight patients in whom a cornual mass but no gestational sac was demonstrated (Figs 3, 5). We believe that this line represents either the endometrial canal (Figs 1, 3, 5) or the interstitial portion of the Fallopian tube (Fig 4), depending on the size of the interstitial pregnancy. We refer to this finding as the interstitial line sign.

In this portion of the study, the sensitivity of the interstitial line sign was 92%. The sensitivity of myometrial thinning was 100% for patients with a sonographically demonstrable gestational sac, but only 33% for all patients with an interstitial ectopic pregnancy. The sensitivity of sac eccentricity was 75% in patients with a demonstrable gestational sac and 25% in all patients with an interstitial ectopic pregnancy.

The interstitial line sign was first proposed in August 1991. Since that time, 2,974 first-trimester sonograms have been performed in our department, with no false-positive diagnoses obtained by using the interstitial line sign. The last five cases in the series were diagnosed during this period.

Figure 1. Interstitial pregnancy at 8 weeks menstrual age in a 32-year-old patient. (a) Transvesical sonogram in the transverse plane demonstrates an eccentric gestational sac (U = uterus, S = gestational sac). (b) Transvesical sonogram in the transverse plane 2-3 mm superior to the scanning plane in a demonstrates the endometrial canal (arrow) abutting the center of the trophoblast (arrowheads) surrounding the interstitial pregnancy. (c) Transvesical sonogram obtained in the longitudinal oblique plane demonstrates thinning of the myometrial mantle (arrows).

Figure 2. (a) Longitudinal and (b) transverse transvesical sonograms obtained in a 19-year-old patient with an interstitial pregnancy at 12 weeks menstrual age. The entire uterus has rotated because of the gestational sac, resulting in a midline position of the sac (Ruge-Simon syndrome). The myometrial mantle is thinned. Visualization of the endometrial canal is enhanced because of air (arrows in a) introduced at the time of a failed therapeutic abortion. The endometrial canal extends into the center of the gestational sac.

Figure 3. Sagittal oblique endovaginal sonogram was obtained in a 27-year-old patient with a right interstitial pregnancy at 10 weeks menstrual age. The endometrial canal (arrow) abuts the interstitial pregnancy, which is seen as a heterogeneous mass in the right cornual region.
Table 1
Sonographic Findings in 12 Patients with Interstitial Ectopic Pregnancy

<table>
<thead>
<tr>
<th></th>
<th>Sac present (n = 4)</th>
<th>Sac absent (n = 8)</th>
<th>Total (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eccentric Sac</td>
<td>3</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Myometrial Thinning</td>
<td>4</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Interstitial Line</td>
<td>4</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Inhomogeneous Mass</td>
<td>0</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

As part of a separate study, we reviewed all ectopic pregnancies in our institution from January 1989 until July 1992. There were 288 ectopic pregnancies, of which six (2.1%) were interstitial. The interstitial line sign was positive in all six of the interstitial ectopic pregnancies. None of the remaining 282 noninterstitial ectopic pregnancies demonstrated the interstitial line.

Doppler examination showed increased vascularity in the cornual region in four of five patients. Typical peritrophoblastic flow was present in these four patients (Fig 5). In the other patient only a limited Doppler examination was performed. The diagnosis had already been made on the basis of the imaging findings. Only one Doppler image was available for review; it showed no definite flow and provided no additional information.

Part 2
The findings in the 40 patients are summarized in Table 2. The interobserver variation for the interstitial line was excellent. There was complete agreement between the three observers in 37 of the 40 patients. The observers agreed on gestational sac location in 31 of 40 patients and on the presence or absence of myometrial thinning in 34 of 40. Kappa statistics were used to assess interobserver correlation (9). The $\kappa$ value is a measure of interobserver correlation. The value ranges from 0, which is entirely random, to 1, which indicates complete interobserver agreement. Values between 0.40 and 0.75 indicate fair to good interobserver correlation, and values greater than 0.75 indicate excellent interobserver agreement (9). The $\kappa$ values were 0.683 for eccentric sac location, 0.758 for myometrial thinning, and 0.848 for the interstitial line.

The correct diagnosis was made 30 of 30 times in the normal intrauterine pregnancy group, but in two, follow-up examinations were requested to exclude interstitial pregnancy, as the gestational sac was believed to be eccentric. In the pseudointerstitial group (n = 30), the diagnoses were normal intrauterine pregnancy in 15, eccentric and requiring follow-up to exclude interstitial pregnancy in eight, interstitial ectopic pregnancy in five, and noninterstitial ectopic pregnancy in two. The diagnosis was correct 28 of 30 times in the noninterstitial ectopic pregnancies. In two instances the patients were believed to have ectopic pregnancies that may have been interstitial. There were 25 of 30 correct diagnoses in the interstitial pregnancy group. The diagnoses were noninterstitial ectopic in four and eccentric intrauterine pregnancy requiring follow-up in one.

One false-positive finding of an interstitial line occurred in a patient with a right ectopic pregnancy and a decidual cast. The correct diagnosis was made in this case, but it was believed by one radiologist that the line was questionably visible on one transvesical image.

The accuracy of the interstitial line is compared with that of eccentricity of the gestational sac and thinning of the myometrium in Table 3. The values were calculated to include and exclude the group of eccentric-appearing but normal gestational sacs (pseudointerstitial pregnancies).

DISCUSSION
Interstitial ectopic pregnancies represent 1.8% of all ectopic pregnancies.
in our center, which is consistent with the published literature (1-5). Interstitial ectopic pregnancy is considered to be an emergency because of the risk of rupture and catastrophic hemorrhage (3). Immediate and accurate diagnosis is essential.

Previous reports have described eccentric gestational sac location (3-7) and thinning of the myometrial mantle to less than 5 mm (3,4) as indicators of interstitial ectopic pregnancy. In our series, these findings had low sensitivity because only four of 12 patients had sonographically identifiable gestational sacs. Anecdotal experience in our center suggests that false-positive diagnoses of interstitial ectopic pregnancies occur with both of these findings. Although not part of this series, false-positive diagnoses precipitated our search for an accurate and reliable indicator of interstitial pregnancy.

We found that in patients with interstitial ectopic pregnancies, it is possible to visualize an echogenic line extending into the cornual region and abutting the midportion of the interstitial mass or gestational sac. In patients in whom the decidua vera is prominent and in whom the interstitial pregnancy is not too large, a thin line can be shown to extend from the thick decidua vera to the cornual region (Fig 4). In these patients the thin line appears to represent the interstitial portion of the tube. In patients with larger interstitial pregnancies (Figs 1-3), the line probably represents the endometrial canal.

Because the pregnancy is situated in the interstitial portion of the fallopian tube, a double decidual sign is not present. In one patient in our series, a small amount of hemorrhage adjacent to the interstitial gestational sac mimicked a double decidual sign (Fig 4). The line sign was clearly positive in this patient, and the diagnosis of interstitial pregnancy was made on this basis.

The line sign is a sensitive indicator of interstitial ectopic pregnancy. In our series the line sign was positive in 11 of 12 patients. The diagnosis would have been made in only four of 12 patients by using eccentric location of the gestational sac and thinning of the myometrium to less than 5 mm as the only criteria. The interstitial line sign was positive in each of these four patients.

The retrospective nature of this study, combined with the relatively low prevalence of interstitial ectopic pregnancy, makes accurate assessment of predictive values and specificity somewhat difficult. From August 1991, when the line sign was first proposed, until February 1993, however, we performed 2,974 first-trimester sonography procedures with no false-positive results. During that period, the last five patients in our series all had positive interstitial line signs.

There were also no false-positive diagnoses of interstitial ectopic pregnancy in 282 noninterstitial ectopic pregnancies reviewed as part of a separate study. These findings lead us to believe that the interstitial line is a very specific sign of interstitial ectopic pregnancy.

In an attempt to establish the accuracy of the interstitial line sign, the US images obtained in 40 patients were reviewed by three radiologists who were unaware of the diagnoses. Although this may not be an exact measure of the accuracy of the interstitial line sign, it provides a good comparison with the previously described signs of interstitial ectopic pregnancy. Although performing only a film review may make diagnosis of interstitial ectopic pregnancy difficult, since a large amount of the information is acquired by means of real-time assessment, we believed this would equally hamper assessment of all three signs. In the two patients with proved interstitial pregnancies in whom there was disagreement about the presence of the interstitial line, at re-review the
line was believed to be present but had been overlooked because it was demonstrated on only one image in each patient.

There was less interobserver variation in the interstitial line sign than in the other two signs of interstitial ectopic pregnancy, although the difference in the $\kappa$ values was not statistically significant. The line sign is somewhat less subjective than eccentric location of the sac and is difficult to "create" in a patient in whom there is no interstitial pregnancy.

The involved radiologists believed that the line was helpful in making the diagnosis of interstitial ectopic pregnancy. There were five misdiagnoses of interstitial ectopic pregnancy on the basis of eccentric sac or myometrial thinning. Two patients with suspected ectopic pregnancy were also believed to have possible interstitial ectopic pregnancy. The interstitial line was not present in any of these cases. Also, there were 10 other patients with intrauterine pregnancies in whom the diagnosis was indeterminate on the basis of sac location and myometrial thinning. In all of these patients the line sign was absent.

The interstitial line had better sensitivity, specificity, and positive and negative predictive values than the other two signs of interstitial ectopic pregnancy in our review. Because the presence of such a large group of eccentric but normal gestational sacs is unlikely to occur in a routine population and may bias the results, we recalculated the values, including only the 10 normal pregnancies, 10 ectopic pregnancies, and 10 interstitial ectopic pregnancies. Even in this smaller group the interstitial line was more accurate than the other signs (Table 3), and interobserver variation was still better with complete agreement in 27 of 30 cases for the interstitial line, 26 of 30 for myometrial thinning, and 24 of 30 for eccentric sac position.

In our experience, the line sign is an accurate indicator of interstitial ectopic pregnancy. When positive, this sign is more useful than other previously published findings in the diagnosis of interstitial pregnancy. In practice, we use a combination of the three signs in the diagnosis of interstitial pregnancy.

References
8. Nyberg DA, Laing FC, Filly RC, Uri-Simmons M, Jeffery RB Jr. Ultrasonographic differentiation of the gestational sac of early intrauterine pregnancy from the pseudogesta-